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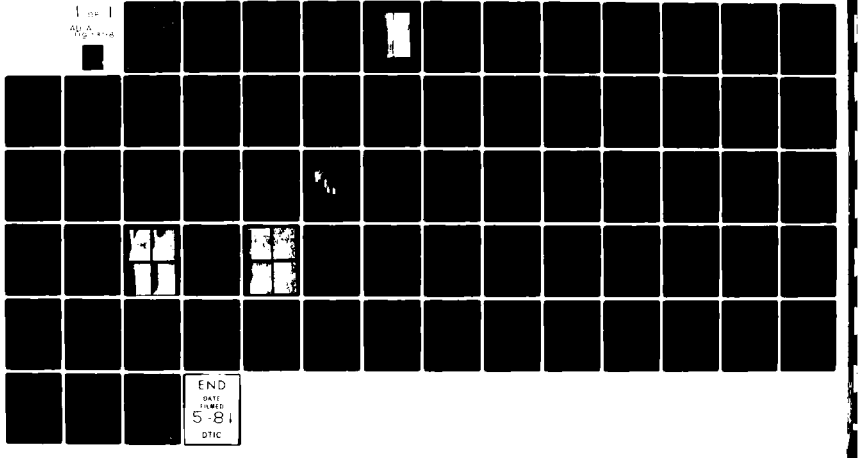

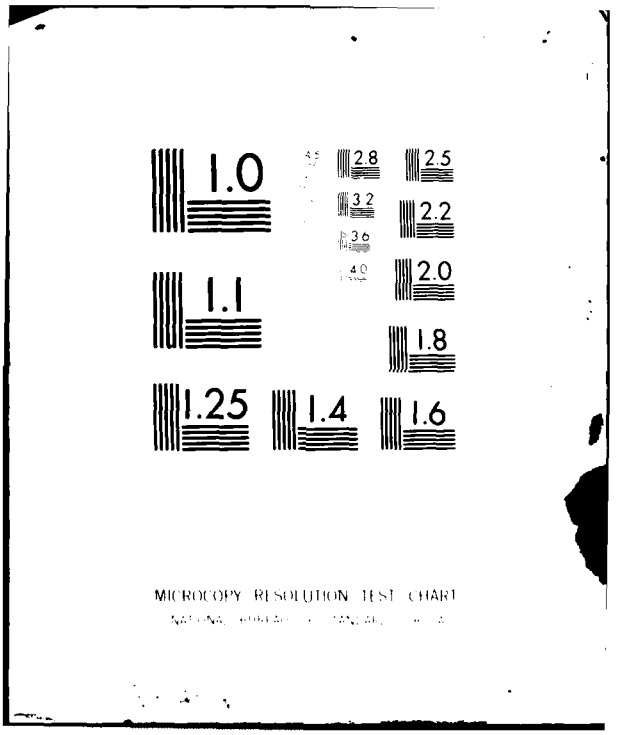
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MICROCOPY RESOLUTION TEST CHART

DELAWARE RIVER BASIN,
BRANCH OF HORNBECKS CREEK, PIKE COUNTY,

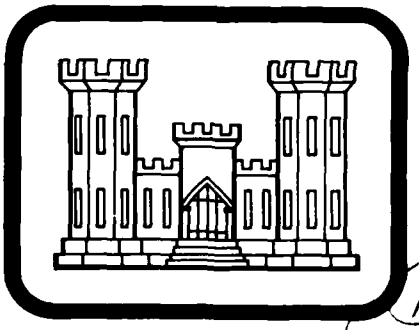
PENNSYLVANIA

NORTH LAKE DAM

NDI I.D. NO. PA-00268,
PENNDER I.D. NO. 52-180

MARCON, INC.

PHASE I INSPECTION REPORT,
NATIONAL DAM INSPECTION PROGRAM



PREPARED FOR

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

DACW31-81-C-0015

PREPARED BY

GAI CONSULTANTS, INC.
570 BEATTY ROAD
MONROEVILLE, PENNSYLVANIA 15146

JANUARY 1981

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established guidelines, the Spillway Design Flood is based on the estimated Probable Maximum Flood (greatest reasonably possible storm runoff) for the region, or fractions thereof. The Spillway Design Flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition, and the downstream damage potential.

Breach analyses are performed, when necessary, to provide data to assess the potential for downstream damage and possible loss of life. The results are based on specific theoretical scenarios peculiar to the analysis of a particular dam and are not applicable to other related studies such as those conducted under the Federal Flood Insurance Program.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

ABSTRACT

North Lake Dam: NDI I. D. No. PA-00268

Owner: Marcon, Inc.

State Located: Pennsylvania (PennDER I.D No. 52-180)

County Located: Pike

Stream: Branch of Hornbecks Creek

Inspection Date: 16 October 1980

Inspection Team: GAI Consultants, Inc.
570 Beatty Road
Monroeville, Pennsylvania 15146

Based on a visual inspection, operational history, and available engineering data, the dam is considered to be in fair condition.

The size classification of the facility is small and the hazard classification is considered to be high. In accordance with the recommended guidelines, the Spillway Design Flood (SDF) ranges between the 1/2 PMF (Probable Maximum Flood) and the PMF. Since the facility is classified near the lower bounds of the small category, the SDF for the facility is considered to be the 1/2 PMF. Results of the hydrologic and hydraulic analysis indicate the facility will pass and/or store approximately 24 percent of the PMF prior to embankment overtopping, assuming the existing earth dike across the spillway is removed. The conditions of overtopping are not, however, considered sufficient to cause failure of the dam. Thus, as North Lake Dam cannot accommodate a flood of 1/2 PMF magnitude, its spillway is considered to be inadequate, but not seriously inadequate.

It must be emphasized, however, that if the dike were not removed and present conditions were to persist, the spillway at North Lake Dam would accommodate only a minimal percentage of the PMF. Moreover, the entire embankment would likely be overtopped and could fail, possibly threatening lives and property downstream.

It is recommended that the owner immediately:

a. Remove the earth and rock dike from the spillway channel entrance in order to provide for maximum unobstructed flow. In addition, excess vegetation should be cleared from along the spillway discharge channel that parallels the downstream embankment toe.

b. Provide interim erosion protection along the spillway right sidewall adjacent the embankment, as well as, along the crest and slopes of the low portion of the embankment immediately to the right of the spillway until a more formal spillway assessment is completed.

c. Retain the services of a registered professional engineer experienced in the hydraulics and hydrology of dams to more accurately assess the adequacy of the spillway and to prepare recommendations deemed necessary to make the facility hydraulically adequate.

d. Provide means for controlling flow through the outlet conduit at its inlet end or a plan to block flow at the inlet should emergency conditions develop along the length of the conduit within the embankment. In addition, the discharge end of the conduit should be cleared of all obstructing materials that may hamper discharge.

e. Continue to observe in all future inspections the seepage at the downstream embankment toe in the vicinity of the outlet conduit noting any changes in its general condition.

f. Backfill and regrade the tire ruts observed along the embankment crest.

g. Develop formal manuals of operation and maintenance to ensure the future proper care and operation of the facility. Included in the manuals should be provisions to clear excess vegetation from the embankment slopes on a regular basis to afford an unobstructed view of the facility.

h. Develop a formal warning system for the notification of downstream inhabitants should hazardous embankment conditions develop. Included in the plan should be provisions for around-the-clock surveillance of the facility during periods of unusually heavy precipitation.

GAI Consultants, Inc.

Bernard M. Mihalcin, P.E.

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
BERNARD M. MIHALCIN
ENGINEER
20371-E

Date 28 January 1981

Approved by:

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

Date 4 MARCH 81

OVERVIEW PHOTOGRAPH

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
NORTH LAKE DAM
NDI# PA-00268, PENNDER# 52-180

SECTION 1
GENERAL INFORMATION

1.0 Authority.

The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

1.1 Purpose.

The purpose is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. North Lake Dam is an earth embankment approximately 18 feet high and 730 feet long, including spillway. The facility is provided with an uncontrolled, roughly trapezoidal shaped spillway channel cut through soil and rock at the left abutment. Drawdown capability is provided by a 12-inch diameter cast iron pipe (CIP) that discharges at the downstream embankment toe. Flow through the conduit is manually controlled at the discharge end by a 12-inch diameter gate valve.

b. Location. North Lake Dam is located on a branch of Hornbecks Creek in Delaware Township, Pike County, Pennsylvania. The facility is located approximately 1,500 feet upstream and west of Wild Acres Lake, and about five miles from U. S. Route 209 which parallels the Delaware River in this area. The dam, reservoir and watershed are contained within the Lake Maskenozha, Pennsylvania-New Jersey, 7.5 minute U.S.G.S. topographic quadrangle (see Figure 1, Appendix E). The coordinates of the dam are N41°12.7' and W74°57.4'.

c. Size Classification. Small (18 feet high, 112 acre-feet storage capacity at top of dam).

d. Hazard Classification. High (see Section 3.1.e).

e. Ownership. Marcon, Inc.
155 Willowbrook Boulevard
P. O. Box 460
Wayne, New Jersey 07470
Attn: Joseph J. Marone
Vice President

f. Purpose. Recreation.

g. Historical Data. No information relative to the history of North Lake Dam is available from PennDER files. A representative of Monroe Engineering, Inc. (subsidiary of Marcon, Inc.) indicated the dam was designed by Monroe Engineering and constructed by G.H. Litts of East Stroudsburg, Pennsylvania in 1972.

1.3 Pertinent Data.

a. Drainage (square miles). 0.5

b. Discharge at Dam Site.

Discharge Capacity of Outlet Conduit - Discharge curves are not available.

Discharge Capacity of Spillway at Maximum Pool ≅ 240 cfs (see Appendix D, Sheet 10).

c. Elevations (feet above mean sea level). The following elevations were obtained from field measurements based on the assumed elevation of normal pool at 1125.0 feet as estimated from Figure 1, Appendix E (also see Appendix D, Sheet 1). There are no drawings available which indicate design elevations or depicting design dimensions.

Top of Dam	1227.0 (field).
Maximum Design Pool	Not known.
Maximum Pool of Record	Not known.
Normal Pool	1225.0 (assumed datum).
Spillway Crest	1225.0 (field).
Top of Dike in Spillway	1226.8 (field).
Upstream Inlet Invert	Not known.
Downstream Outlet Invert	1208.8 (field).
Streambed at Dam Centerline	Not known.
Maximum Tailwater	Not known.

d. Reservoir Length (feet).

Top of Dam	1700
Normal Pool	1600

e. Storage (acre-feet).

Top of Dam	112
Normal Pool	80

f. Reservoir Surface (acres).

Top of Dam	17
Normal Pool	15

g.	Dam.	
	Type	Earth.
	Length	700 feet (excluding spillway).
	Height	18 feet (field measured; embankment crest to downstream outlet invert).
	Top Width	15 feet (minimum). 23 feet (maximum).
	Upstream	Varies left to right; 4.5H:1V to 2H:1V.
	Downstream Slope	4.5H:1V.
	Zoning	Not known.
	Impervious Core	Not known.
	Cutoff	Not known.
	Grout Curtain	Not known.
h.	Diversion Canal and Regulating Tunnels.	None.
i.	Spillway.	
	Type	Uncontrolled, roughly trapezoidal shaped channel with no regulating weir, cut through soil and rock at the left abutment. Discharge regulated by channel slope.
	Crest Elevation	1225.0 feet (assumed elevation of normal pool: see Appendix D, Sheets 1 and 5).
	Crest Length	Trapezoidal shaped cross section; 30 feet at top and 25 feet at bottom.
j.	Outlet Conduit.	
	Type	12-inch diameter cast iron pipe.

Length	Not known.
Closure and Regulating Facilities	Flow through the outlet conduit is manually controlled by a 12-inch diameter gate valve located at its discharge end.
Access	The control mechanism is accessible by foot at the downstream embankment toe.

SECTION 2

ENGINEERING DATA

2.1 Design.

a. Design Data Availability and Sources. No design reports, calculations, miscellaneous design data, correspondence, state inspection reports, design or construction drawings are available from either the owner or the PennDER.

b. Design Features.

1. Embankment. Based strictly on visual observations and field measurements, general statements can be made regarding the embankment design. The dam is an 18-foot high embankment 730 feet long, including spillway. It is broad based with a downstream embankment face set on a relatively gentle slope of 4.5H:1V and an upstream embankment face whose slope varies (above normal pool level), from left to right, from 4.5H:1V to 2H:1V. The embankment crest varies in width being narrowest (15 feet minimum width) near the right abutment and widest (23 feet maximum width) near the spillway. There is no clearly defined riprap zone along the upstream embankment face; however, the embankment fill is dense and very rocky and appears adequately durable. Surface soil consists of a brown clayey silt and rock fragments which appears suitable for embankment construction. No information is available relative to the internal composition or foundation design of this structure.

2. Appurtenant Structures.

a) Spillway. The spillway is an uncontrolled, roughly trapezoidal shaped channel cut through soil and rock at the left abutment. The spillway was constructed without any type of regulating weir or well defined control section. Recently, in order to raise the level of normal pool, a small earth and rock dike was placed across the channel entrance, effectively blocking spillway discharges (see Photographs 5 and 6).

b) Outlet Conduit. The outlet conduit is a 12-inch diameter cast iron pipe exposed only at its discharge end located along the downstream embankment toe. At this point, flow is manually regulated by a 12-inch diameter gate valve.

c. Specific Design Data and Criteria. No design data or information relative to design procedures are available.

2.2 Construction Records.

No construction records available for this facility.

2.3 Operational Records.

Records of the day-to-day operation of the facility are not maintained.

2.4 Other Investigations.

There are no available records concerning formal studies or investigations of North Lake Dam.

2.5 Evaluation.

There is no information available relative to the design or construction of this facility. Visual inspection indicates that the structure has a broad base and a relatively gentle downstream embankment face. The surface soil appears suitable for earth embankment construction. The data gathered during the inspection are considered sufficient to make a reasonable Phase I assessment of the facility.

SECTION 3

VISUAL INSPECTION

3.1 Observations.

a. General. The general appearance of the facility suggests the dam and its appurtenances are in fair condition.

b. Embankment. Observations made during the visual inspection indicate the embankment is in fair condition, but in need of general maintenance. No evidence of seepage through the downstream embankment face, sloughing, erosion or animal burrows was observed. The embankment crest is noticeably low (in excess of 1-foot) near the spillway relative to the remainder of the crest. About two-thirds of the embankment is overgrown along an area extending approximately 400 feet to the right of the spillway. The vegetation is characterized as primarily brush and high weeds with clumps of small trees strewn throughout (see Photographs 2 and 3). In contrast, much of the embankment crest and upstream face are bare and unprotected with only light vegetation visible (see Photographs 2 and 4). Several long tire ruts scar the crest near the spillway. A small area characterized by swamplike vegetation is located about 350 to 375 feet from the right abutment along the downstream embankment toe. Seepage was observed at the downstream embankment toe near the outlet conduit flowing at a rate of about two to three gpm (see Photograph 8). The flow is suspected of being either seepage through the embankment foundation, or perhaps drainage from a concealed toe drain. A precise assessment of the condition is difficult without adequate design data and drawings.

c. Appurtenant Structures.

1. Spillway. The spillway is considered to be in poor condition. Efforts to raise the pool level by placing a small earth and rock dike across the channel entrance has resulted in a substantial reduction of the discharge capacity of the channel. The channel is apparently founded in rock as evidenced by the large boulders visible in the discharge channel (see Photograph 6); however, it is poorly defined with non-uniform side slopes. The right spillway wall appears to be formed by the embankment and is not adequately protected. Rock is scattered along the discharge channel, but does not appear to have been formally placed and probably provides only minimal erosion protection. The portion of the discharge channel that parallels the downstream embankment toe is heavily overgrown with brush and small trees that could potentially obstruct flow.

2. Outlet Conduit. The only visible section of the outlet conduit is its discharge end and control mechanism located along the downstream embankment toe. Provisions to control flow at the upstream end during emergency conditions are not available. The control mechanism is reportedly functional; however, it was not

operated in the presence of the inspection team. The conduit is partially submerged by silt and water which emanates from an unidentified seepage source located several feet above and to the left of the conduit (see Photographs 7 and 8). The area should be cleared and the seepage observed in future inspections.

d. Reservoir Area. The general area surrounding the reservoir is composed of moderate to steep slopes that are heavily forested. Several dwellings are located around the perimeter of the reservoir; however, the watershed is primarily undeveloped at present. No signs of slope distress were observed.

e. Downstream Channel. Discharges from North Lake Dam flow into a narrow, wooded valley with steep confining slopes. The first inhabitable structure located downstream is a single cottage situated well above the streambed immediately below the embankment. As the stream approaches Wild Acres Lake, about 1,500 feet downstream of North Lake Dam, the channel grade flattens. Several dwellings are situated within the reach between the dams sufficiently near the channel to possibly be affected by the high flows resulting from an embankment breach. The population of the valley between the dam and Wild Acres Lake is estimated at between 20 and 30 persons during the peak vacation seasons and on weekends. Thus, the hazard classification for North Lake Dam is considered to be high.

Wild Acres Lake is located about 1,500 feet downstream of North Lake. It is a larger reservoir than North Lake having a surface area of 82 acres at normal pool. The impounding structure is located at the northeast end of the reservoir opposite the inlet from North Lake Dam. Wild Acres Lake Dam is an earth and rockfill embankment about nine feet high and 420 feet long (Phase I Inspection Report, National Dam Inspection Program, NDI I.D. No. PA-00407, prepared by GAI Consultants, Inc., Dated January 1981). The spillway has 1.3 feet of available freeboard and 110 acre-feet of flood storage.

3.2 Evaluation.

The overall appearance of the facility suggests it to be in fair condition. The facility is in need of a program of regular routine maintenance with specific provisions to annually cut back excess vegetation from the embankment and spillway channel and to maintain the operability of the outlet conduit. The seepage observed by the inspection team near the outlet conduit should be observed in future inspections and remedial measures implemented, if necessary. Immediate action should also be taken to remove the small earth and rock dike presently obstructing the spillway and to provide adequate erosion protection along that portion of the embankment which forms the right sidewall of the channel. A plan to control flow at the upstream end of the outlet conduit, if emergency conditions develop within the outlet pipe beneath the embankment, should also be devised. Tire ruts along the crest should be backfilled or regraded.

SECTION 4

OPERATIONAL PROCEDURES

4.1 Normal Operating Procedure.

North Lake Dam is essentially a self-regulating facility. That is, under normal operating conditions, the outlet conduit is closed and excess inflows are automatically discharged through the uncontrolled spillway. The outlet conduit control mechanism is not operated on a regular basis, but, is reportedly functional. No formal operations manual is available.

4.2 Maintenance of Dam.

No formal maintenance program has been established at this facility and no formal maintenance manuals are available. The facility is reportedly maintained on an unscheduled basis by the owner's maintenance staff.

4.3 Maintenance of Operating Facilities.

See Section 4.2 above.

4.4 Warning System.

No formal warning system is presently in effect.

4.5 Evaluation.

The general appearance of the facility indicates a lack of adequate maintenance. No formal operations or maintenance manuals are available, but are recommended to ensure the proper future care and operation of the facility. In addition, formal warning system procedures should be incorporated into these manuals to provide for the protection of downstream residents should hazardous embankment conditions develop.

SECTION 5

HYDROLOGIC/HYDRAULIC EVALUATION

5.1 Design Data.

No formal design reports, calculations, or miscellaneous design data are available for the facility.

5.2 Experience Data.

Daily records of reservoir levels and/or spillway discharges are not available.

5.3 Visual Observations.

The earth and rock dike recently placed across the spillway channel substantially reduces its discharge capacity and should be removed immediately. Furthermore, additional erosion protection should be provided along that portion of the embankment that abuts the right sidewall of the spillway channel. The downstream channel should also be cleared of brush and debris to provide unobstructed discharge.

5.4 Method of Analysis.

The facility has been analyzed in accordance with the procedures and guidelines established by the U. S. Army, Corps of Engineers, Baltimore District, for Phase I hydrologic and hydraulic evaluations. The analysis has been performed utilizing a modified version of the HEC-1 program developed by the U. S. Army, Corps of Engineers, Hydrologic Enginering Center, Davis, California. Analytical capabilities of the program are briefly outlined in the preface contained in Appendix D.

5.5 Summary of Analysis.

a. Spillway Design Flood (SDF). In accordance with procedures and guidelines contained in the National Guidelines for Safety Inspection of Dams for Phase I Investigations, the Spillway Design Flood (SDF) for North Lake Dam ranges between the 1/2 PMF (Probable Maximum Flood) and the PMF. This classification is based on the relative size of the dam (small) and the potential hazard of dam failure to downstream developments (high). Since the facility is classified near the lower bounds of the small category, the SDF for the facility is considered to be the 1/2 PMF.

b. Results of Analysis. North Lake Dam was evaluated under near normal operating conditions. That is, the reservoir was initially at its normal pool or spillway elevation of approximately 1225.0 feet, with the spillway channel discharging freely. The spillway consists of a roughly trapezoidal shaped channel cut through soil and rock at the left abutment. At the time of inspection there was a small earth and rock dike obstructing the spillway channel, built for the purpose of raising the reservoir level. It was assumed in the analysis that the obstruction was removed, since the available freeboard with the dike in place was only about 0.2 feet, resulting in a greatly reduced spillway capacity. Also, the outlet conduit was assumed to be nonfunctional for the purpose of analysis, since the flow capacity of the conduit is not such that it would significantly increase the total discharge capabilities of the dam and reservoir. All pertinent engineering calculations relative to the evaluation of North Lake Dam are provided in Appendix D.

Overtopping analysis (using the Modified HEC-1 Computer Program) indicated that the discharge/storage capacity of North Lake Dam can accommodate only about 24 percent of the PMF prior to embankment overtopping. Under 1/2 PMF (SDF) conditions, the embankment was overtopped for about 5.0 hours, by depths of up to 1.0 foot (see Appendix D, Summary Input/Outout Sheets, Sheet D). However, only about 30 feet of the 700-foot long embankment was actually overtopped. This occurred at a low area located adjacent to the spillway right sidewall. Since only a small portion of the embankment is subject to overtopping, and the structure is broad based with a relatively gentle downstream slope; the dam appears unlikely to catastrophically fail under less than 1/2 PMF conditions. Thus, breach analyses were not conducted.

5.6 Spillway Adequacy.

As presented previously, assuming the existing earth dike across the spillway is removed, North Lake Dam can accommodate only about 24 percent of the PMF prior to embankment overtopping. Though the facility cannot accommodate a flood of at least 1/2 PMF (SDF) magnitude without embankment overtopping, the possible downstream consequences of embankment failure due to overtopping were not evaluated, since it was concluded that the dam was not likely to fail under these conditions (in accordance with Corps directive ETL-1110-2-234). Thus, as North Lake Dam cannot accommodate a flood of 1/2 PMF magnitude, its spillway is considered to be inadequate, but not seriously inadequate.

It must be emphasized, however, that if the dike were not removed and present conditions were to persist, the spillway at North Lake Dam would accommodate only a minimal percentage of the PMF. Moreover, the entire embankment would likely be overtopped and could fail, possibly threatening lives and property downstream.

SECTION 6

EVALUATION OF STRUCTURAL INTEGRITY

6.1 Visual Observations.

a. Embankment. Visual observations and field measurements indicate that the structure is broad-based and the slope of its downstream face is relatively gentle. Both characteristics enhance its overall stability; however, the embankment lacks adequate maintenance and appears somewhat neglected. Seepage was observed along the downstream embankment toe near the outlet conduit. Although it is not presently considered to be serious, this seepage, as well as the swampy condition observed to its right along the downstream embankment toe, should be assessed in all future inspections specifically noting any turbidity and/or changes in rates of flow. The low area along the embankment crest adjacent to the spillway should be raised or provided with adequate erosion protection so that heavy spillway discharges and anticipated overtopping flows do not severely damage or imperil the structure. The tire ruts observed along the embankment crest should be regraded or backfilled.

b. Appurtenant Structures.

1. Spillway. The spillway is considered to be in poor structural condition. Its major deficiency, the earth and rock dike across its crest, is presently a threat to the embankment in that the dike increases the potential for embankment overtopping by reducing the spillway discharge capacity. The overgrowth encountered in the discharge channel along the downstream embankment toe could also potentially obstruct flow, causing spillage out of the channel and perhaps erosion of the downstream toe area. The channel itself, although lacking in formally placed slope protection, is partially cut through rock or rocky soil and appears to be adequately durable except for the portion of the right channel sidewall that appears to be formed by the embankment itself. Additional erosion protection should be provided in this area if it is to continue to function as part of the spillway.

2. Outlet Conduit. The outlet conduit is reportedly functional and in good condition. The discharge end is almost completely covered with saturated silt and should be cleared. The outlet was constructed without a means of controlling flow at the inlet. Provisions should be made for actually controlling or at least blocking the intake in the event of a leak or a rupture within the embankment which could lead to piping or internal erosion.

6.2 Design and Construction Techniques.

No information is available that details the methods of design and/or construction.

6.3 Past Performance.

No records relative to the performance history of this facility are available. The owner's representative stated, however, that the embankment had never been overtopped to his knowledge.

6.4 Seismic Stability.

The dam is located in Seismic Zone No. 1 and may be subject to minor earthquake induced dynamic forces. It is believed that the facility, as constructed, can withstand the expected dynamic forces; however, no calculations and/or investigations were performed to confirm this opinion.

SECTION 7

ASSESSMENT AND RECOMMENDATIONS FOR REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety. The results of this investigation indicate the facility is in fair condition.

The size classification of the facility is small and the hazard classification is considered to be high. In accordance with the recommended guidelines, the Spillway Design Flood (SDF) ranges between the 1/2 PMF (Probable Maximum Flood) and the PMF. Since the facility is classified near the lower bounds of the small category, the SDF for the facility is considered to be the 1/2 PMF. Results of the hydrologic and hydraulic analysis indicate the facility will pass and/or store approximately 24 percent of the PMF prior to embankment overtopping. The conditions of overtopping are not, however, considered sufficient to cause failure of the dam. Thus, as North Lake Dam cannot accommodate a flood of 1/2 PMF magnitude, its spillway is considered to be inadequate, but not seriously inadequate.

It must be emphasized, however, that if the dike were not removed and present conditions were to persist, the spillway at North Lake Dam would accommodate only a minimal percentage of the PMF. Moreover, the entire embankment would likely be overtopped and could fail, possibly threatening lives and property downstream.

b. Adequacy of Information. The available data is considered sufficient to make a reasonable Phase I assessment of the facility.

c. Urgency. The recommendations listed below should be implemented immediately.

d. Necessity for Additional Investigations. Additional investigations are considered necessary to more accurately assess the adequacy of the spillway.

7.2 Recommendations/Remedial Measures.

It is recommended that the owner immediately:

a. Remove the earth and rock dike from the spillway channel entrance in order to provide for maximum unobstructed flow. In addition, excess vegetation should be cleared from along the spillway discharge channel that parallels the downstream embankment toe.

b. Provide interim adequate erosion protection along the spillway right sidewall adjacent the embankment, as well as, along

the crest and slopes of the low portion of the embankment immediately to the right of the spillway until a more formal spillway assessment is completed.

c. Retain the services of a registered professional engineer experienced in the hydraulics and hydrology of dams to more accurately assess the adequacy of the spillway and to prepare recommendations deemed necessary to make the facility hydraulically adequate.

d. Provide means for controlling flow through the outlet conduit at its inlet end or a plan to block flow at the inlet should emergency conditions develop along the length of the conduit within the embankment. In addition, the discharge end of the conduit should be cleared of all obstructing materials that may hamper discharge.

e. Continue to observe in all future inspections the seepage at the downstream embankment toe in the vicinity of the outlet conduit noting any changes in its general condition.

f. Backfill and regrade the tire ruts observed along the embankment crest.

g. Develop formal manuals of operation and maintenance to ensure the proper future care and operation of the facility. Included in the manuals should be provisions to clear excess vegetation from the embankment slopes on a regular basis to afford an unobstructed view of the facility.

h. Develop a formal warning system for the notification of downstream inhabitants should hazardous embankment conditions develop. Included in the plan should be provisions for around-the-clock surveillance of the facility during periods of unusually heavy precipitation.

APPENDIX A

VISUAL INSPECTION CHECKLIST AND FIELD SKETCHES

CHECK LIST
VISUAL INSPECTION
PHASE 1

NAME OF DAM North Lake Dam STATE Pennsylvania COUNTY Pike

NDI # PA — 00268 PENNDER # 52-180

TYPE OF DAM Earth SIZE Small HAZARD CATEGORY High

DATE(S) INSPECTION 16 October 80 WEATHER Overcast TEMPERATURE 65° @ 3:00 pm

POOL ELEVATION AT TIME OF INSPECTION 1223.2 M.S.L.

TAILWATER AT TIME OF INSPECTION N/A M.S.L.

INSPECTION PERSONNEL	OWNER REPRESENTATIVES	*OTHERS*
B. M. Mihalcin	None	
D. J. Spaeder		
D. L. Bonk		

RECORDED BY B. M. Mihalcin

EMBANKMENT

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00268
SURFACE CRACKS	None observed. Crest of embankment is sparsely grass covered with long tire ruts, over 200 feet long, in evidence adjacent the spillway.
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed.
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	No significant erosion observed. Right one-third of downstream slope is grass covered while remaining two-thirds is covered with briars, low shrubs, weeds and small trees (Poplars). Upstream slope is bare in many areas, grass and shrub covered in others. Recently cut tree stumps are evident - should remove roots.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Horizontal - good. Vertical - see "Profile of Dam Crest from Field Survey", Appendix A.
RIPRAP FAILURES	No apparent riprap zone. Embankment fill appears to be dense and very rocky and thus, durable and not easily erodible. No significant erosion was observed. Condition should be observed in future inspections.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Good.

EMBANKMENT

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00268
DAMP AREAS IRREGULAR VEGETATION (LUSH OR DEAD PLANTS)	Small swamplike area located 350 to 375 feet from right abutment along downstream embankment toe. No seepage flow was observed. Area is covered with hydrophilic type vegetation.
ANY NOTICEABLE SEEPAGE	Seepage (≃ 2 to 3 gpm) observed emanating through rock headwall at outlet conduit along downstream embankment toe. Clear with no sediment content evident. May be an obscured toe drain.
STAFF GAGE AND RECORDER	None.
DRAINS	None. See "Any Noticeable Seepage" above.

OUTLET WORKS

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA- 00268
INTAKE STRUCTURE	Submerged, not observed.
OUTLET CONDUIT (CRACKING AND SPALLING OF CONCRETE SURFACES)	Appears to be a 12-inch diameter cast iron pipe; however, only the top portion of its discharge end is visible due to a combination of poor drainage and siltation in this area.
OUTLET STRUCTURE	None. Irregular, hand placed, stone (rubble) headwall at discharge end of conduit along the downstream embankment toe.
OUTLET CHANNEL	Rock lined ditch to confluence with spillway channel about 100 feet below the downstream embankment toe.
GATE(S) AND OPERATIONAL EQUIPMENT	Manually operated gate valve at discharge end of outlet conduit. Substantially covered with sediment, but, otherwise appears operable.

EMERGENCY SPILLWAY

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00268
TYPE AND CONDITION	Uncontrolled, roughly trapezoidal shaped channel cut through rock and soil at the left abutment. No regulating weir. Small, recently constructed earth and rock dike across the spillway crest now serves as the control section.
APPROACH CHANNEL	Natural approach.
SPILLWAY CHANNEL AND SIDEWALLS	Spillway channel has been somewhat covered and obscured by the small earth and rock dike located across its crest. Channel appears to be cut into soil and is probably rocklined beneath the presently covered portions.
STILLING BASIN PLUNGE POOL	None.
DISCHARGE CHANNEL	Rocklined channel to paved road downstream of embankment (channel lenght ≈ 380 feet).
BRIDGE AND PIERS EMERGENCY GATES	

SERVICE SPILLWAY

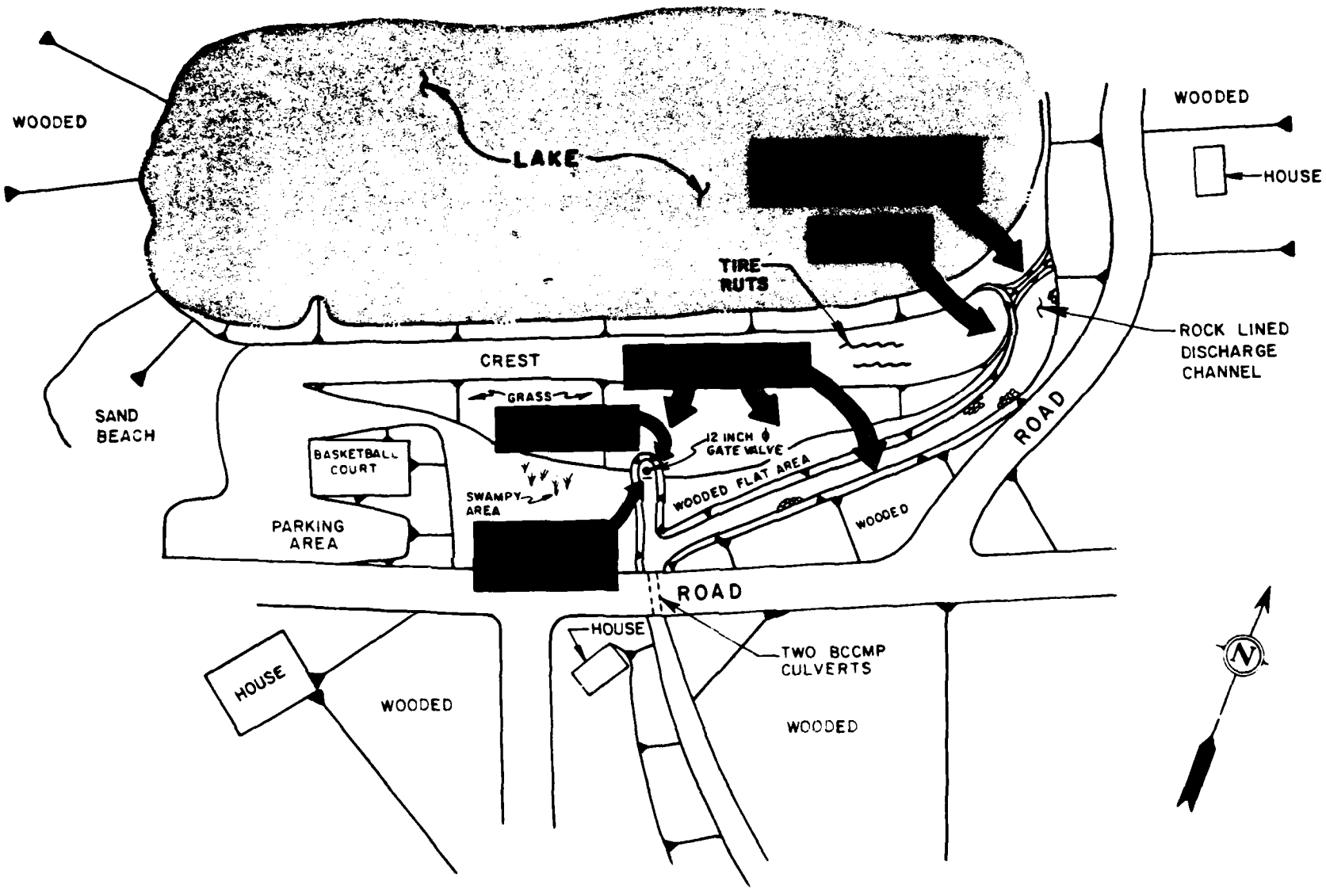
ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00268
TYPE AND CONDITION	N/A
APPROACH CHANNEL	N/A
OUTLET STRUCTURE	N/A
DISCHARGE CHANNEL	N/A

INSTRUMENTATION

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00268
MONUMENTATION SURVEYS	None.
OBSERVATION WELLS	None.
WEIRS	None.
PIEZOMETERS	None.
OTHERS	None.

RESERVOIR AREA AND DOWNSTREAM CHANNEL

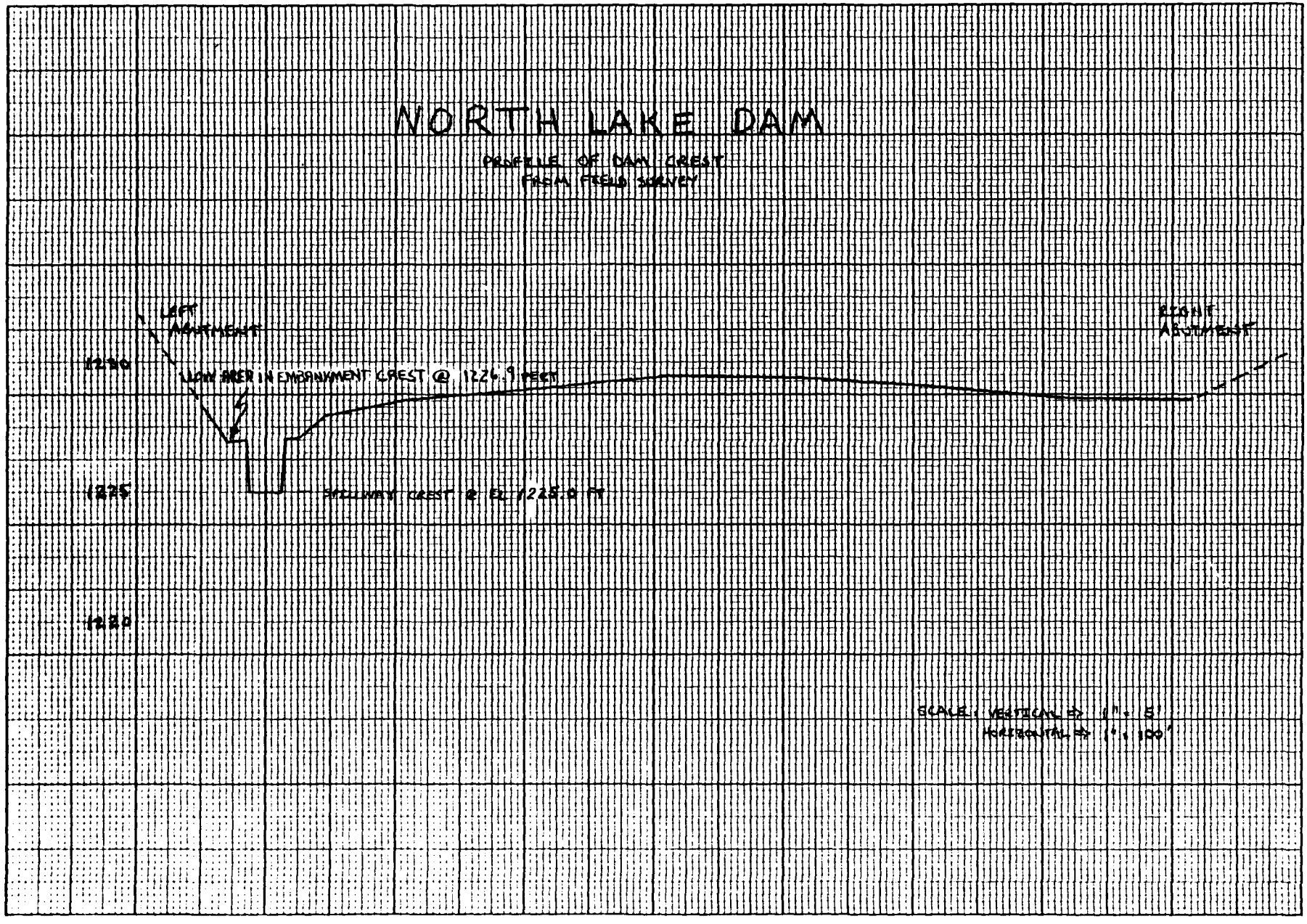
ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00268
SLOPES: RESERVOIR	Gentle to moderate, heavily forested slopes. Partially developed. Surrounding slopes appear to have very little soil cover.
SEDIMENTATION	None evident.
DOWNSTREAM CHANNEL (OBSTRUCTIONS, DEBRIS, ETC.)	Discharges from North Lake Dam pass through four separate road culverts prior to entering Wild Acres Lake.
SLOPES: CHANNEL VALLEY	Discharges from North Lake Dam flow into a narrow, wooded valley with steep confining slopes.
APPROXIMATE NUMBER OF HOMES AND POPULATION	Several dwellings are situated within the 1,500-feet long reach between North Lake Dam and Wild Acres Lake within several feet of the channel bed. The population is estimated at 20 to 30 persons during the peak vacation seasons and on weekends.



NORTH LAKE DAM
GENERAL PLAN - FIELD INSPECTION NOTES

NORTH LAKE DAM

PROFILE OF DAM CREST
FROM FIELD SURVEY



APPENDIX B

ENGINEERING DATA CHECKLIST

CHECK LIST
ENGINEERING DATA
PHASE I

NAME OF DAM North Lake Dam

ITEM	REMARKS NDI# PA - 00268
PERSONS INTERVIEWED AND TITLE	Monroe Engineering, Inc. (Subsidiary of Marcon, Inc.) Leonard Tusar - General Manager Interview took place at Wild Acres Lake Dam several hours prior to the inspection of this facility.
REGIONAL VICINITY MAP	See Figure 1, Appendix E.
CONSTRUCTION HISTORY	Dam designed by Monroe Engineering, Inc., East Stroudsburg, PA, and constructed by G.H. Litts of East Stroudsburg in 1972.
AVAILABLE DRAWINGS	None available.
TYPICAL DAM SECTIONS	None available.
OUTLETS: PLAN DETAILS DISCHARGE RATINGS	None available.

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS	NDI# PA - 00268
SPILLWAY: PLAN SECTION DETAILS	None available.	
OPERATING EQUIP- MENT PLANS AND DETAILS	None available.	
DESIGN REPORTS	None available.	
GEOLOGY REPORTS	None available.	
DESIGN COMPUTATIONS: HYDROLOGY AND HYDRAULICS STABILITY ANALYSES SEEPAGE ANALYSES	None available.	
MATERIAL INVESTIGATIONS: BORING RECORDS LABORATORY TESTING FIELD TESTING	None available.	

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS	NDI# PA · 00268
BORROW SOURCES	Unknown, but probably not from within reservoir area.	
POST CONSTRUCTION DAM SURVEYS	None.	
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None.	
HIGH POOL RECORDS	No formal records available.	
MONITORING SYSTEMS	None.	
MODIFICATIONS	Small earth and rock dike constructed across entire length of spillway, in 1979, in order to raise reservoir level 6-8 inches.	

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS	NDI# PA - 00268
PRIOR ACCIDENTS OR FAILURES	None.	
MAINTENANCE: RECORDS MANUAL	No formal records or manual available.	
OPERATION: RECORDS MANUAL	No formal records or manual available.	
OPERATIONAL PROCEDURES	Self-regulating.	
WARNING SYSTEM AND/OR COMMUNICATION FACILITIES	None.	
MISCELLANEOUS		

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

NDI ID # PA-00268
PENNDER ID # 52-180

SIZE OF DRAINAGE AREA: 0.47 square miles

ELEVATION TOP NORMAL POOL: 1225.0 **STORAGE CAPACITY:** 80 acre-feet.

ELEVATION TOP FLOOD CONTROL POOL: - **STORAGE CAPACITY:** -

ELEVATION MAXIMUM DESIGN POOL: - **STORAGE CAPACITY:** -

ELEVATION TOP DAM: 1227.0 **STORAGE CAPACITY:** 112 acre-feet.

SPILLWAY DATA

CREST ELEVATION: 1225.0 (with earth and rock dike removed).

TYPE: Uncontrolled, roughly trapezoidal channel cut through soil and rock at left abutment.

CREST LENGTH: 25 feet (base width); 30 feet (top width at low top of dam level)

CHANNEL LENGTH: Approximately 380 feet.

SPILLOVER LOCATION: Left abutment.

NUMBER AND TYPE OF GATES: None.

OUTLET WORKS

TYPE: 12-inch diameter cast iron pipe.

LOCATION: Near center of embankment.

ENTRANCE INVERTS: Not known.

EXIT INVERTS: 1208.8 (field).

EMERGENCY DRAWDOWN FACILITIES: 12-inch diameter manually operated gate valve

HYDROMETEOROLOGICAL GAGES

TYPE: None.

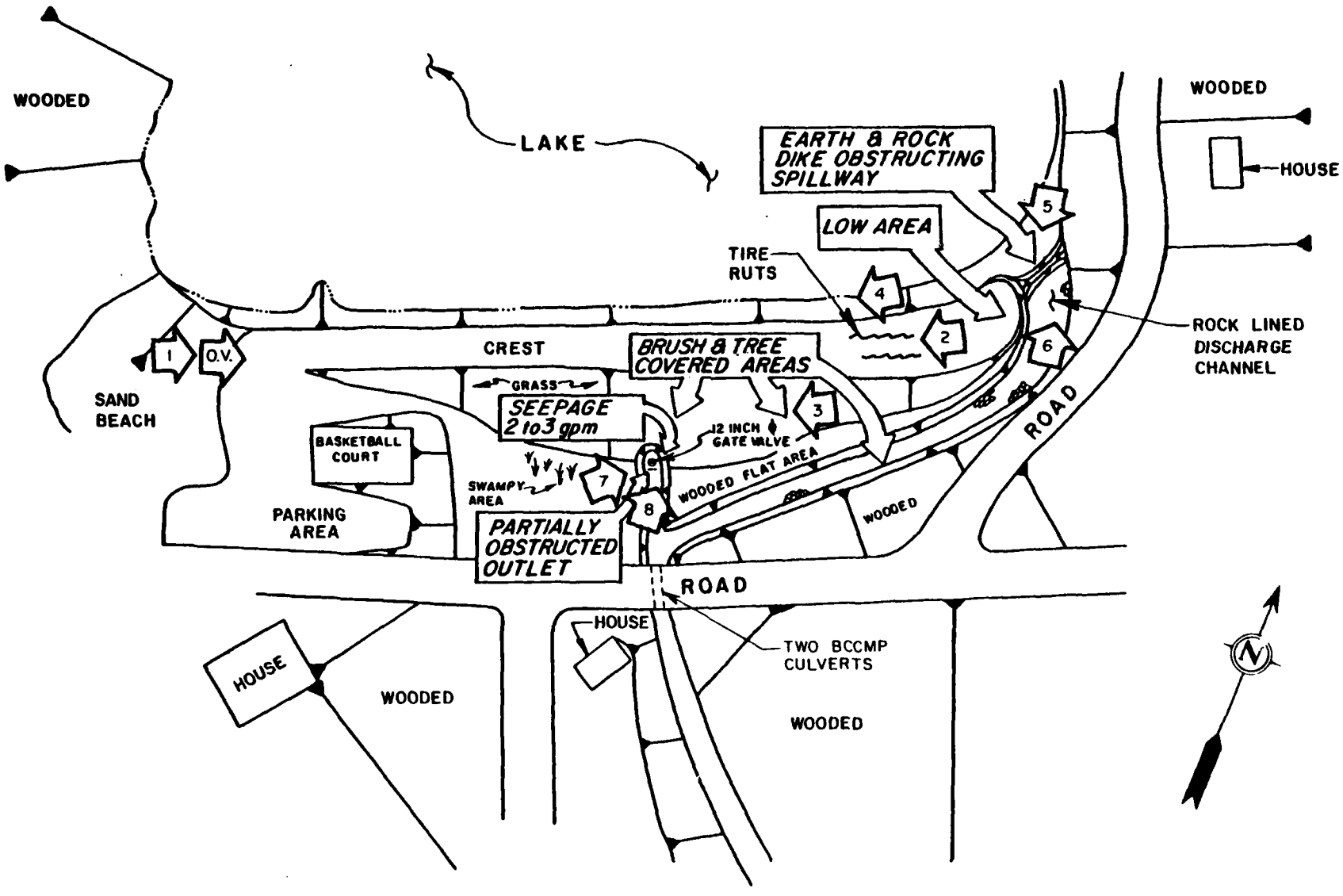
LOCATION: N/A.

RECORDS: N/A.

MAXIMUM NON-DAMAGING DISCHARGE: Not known.

APPENDIX C

PHOTOGRAPHS



NORTH LAKE DAM
PHOTOGRAPH KEY MAP

PHOTOGRAPH 1 Overview of North Lake Dam as seen from the right abutment.

PHOTOGRAPH 2 View across the crest of North Lake Dam looking toward the right abutment.

PHOTOGRAPH 3 View of the brush covered downstream embankment face near the center of the embankment.

PHOTOGRAPH 4 View of upstream embankment face looking toward the right abutment.

1

2

3

4

PHOTOGRAPH 5 View of the spillway channel, looking downstream, as seen from the approach area. Dike in foreground was reportedly constructed to raise pool level.

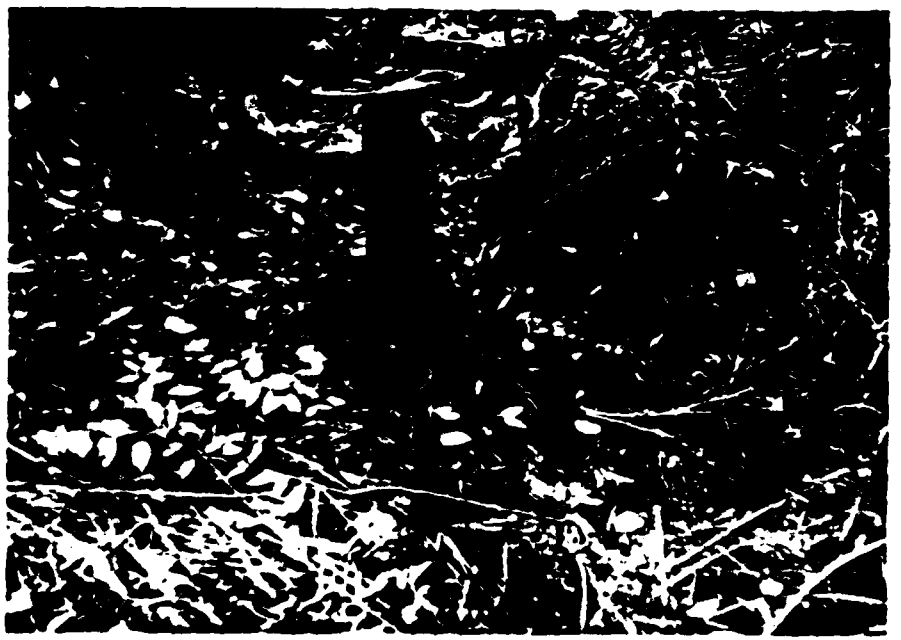
PHOTOGRAPH 6 View, looking upstream, of the spillway crest as seen from the discharge channel approximately 25 feet downstream.

PHOTOGRAPH 7 Close-up view of the outlet conduit control mechanism and partially obstructed outlet located at the downstream embankment toe.

PHOTOGRAPH 8 View of the seepage (≈ 2 to 3 gpm) observed near the outlet conduit along the downstream embankment toe.

5

6



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8

APPENDIX D

HYDROLOGIC AND HYDRAULIC ANALYSES

PREFACE

The modified HEC-1 program is capable of performing two basic types of hydrologic analyses: 1) the evaluation of the overtopping potential of the dam; and 2) the estimation of the downstream hydrologic-hydraulic consequences resulting from assumed structural failures of the dam. Briefly, the computational procedures typically used in the dam overtopping analysis are as follows:

a. Development of an inflow hydrograph(s) to the reservoir.

b. Routing of the inflow hydrograph(s) through the reservoir to determine if the event(s) analyzed would overtop the dam.

c. Routing of the outflow hydrograph(s) from the reservoir to desired downstream locations. The results provide the peak discharge(s), time(s) of occurrence the peak discharge(s), and the maximum stage(s) of each routed hydrograph at the downstream end of each reach.

The evaluation of the hydrologic-hydraulic consequences resulting from an assumed structural failure (breach) of the dam is typically performed as shown below.

a. Development of an inflow hydrograph(s) to the reservoir.

b. Routing of the inflow hydrograph(s) through the reservoir.

c. Development of a failure hydrograph(s) based on specified breach criteria and normal reservoir outflow.

d. Routing of the failure hydrograph(s) to desired downstream locations. The results provide estimates of the peak discharge(s), time(s) to peak and maximum water surface elevation(s) of failure hydrograph(s) for each location.

HYDROLOGY AND HYDRAULIC ANALYSIS
DATA BASE

NAME OF DAM: NORTH LAKE DAM

PROBABLE MAXIMUM PRECIPITATION (PMP) = 22.0 INCHES/24 HOURS (1)

STATION	1	2	3
STATION DESCRIPTION	NORTH LAKE DAM		
DRAINAGE AREA (SQUARE MILES)	0.47		
CUMULATIVE DRAINAGE AREA (SQUARE MILES)	-		
ADJUSTMENT OF PMF FOR DRAINAGE AREA LOCATION (%) (1) Zone 1 6 HOURS 12 HOURS 24 HOURS 48 HOURS 72 HOURS	 111 123 133 142 -		
SNYDER HYDROGRAPH PARAMETERS ZONE (2) C_p (3) C_t (3) L (MILES) (4) L_{ca} (MILES) (4) $t_p = C_t (L \cdot L_{ca})^{0.3}$ (HOURS)	 1 0.45 1.23 1.5 0.7 1.25		
SPILLWAY DATA (5) CREST LENGTH (FEET) FREEBOARD (FEET)	 25 2.0		

(1) HYDROMETEOROLOGICAL REPORT 33, U.S. ARMY CORPS OF ENGINEERS, 1956.
(2) HYDROLOGIC ZONE DEFINED BY CORPS OF ENGINEERS, BALTIMORE DISTRICT, FOR DETERMINATION OF SNYDER COEFFICIENTS (C_p AND C_t).
(3) SNYDER COEFFICIENTS
(4) L = LENGTH OF LONGEST WATERCOURSE FROM DAM TO BASIN DIVIDE
L_{ca} = LENGTH OF LONGEST WATERCOURSE FROM DAM TO POINT OPPOSITE BASIN CENTROID.
(5) SEE SHEET 5.

SUBJECT DAM SAFETY INSPECTION
NORTH LAKE DAM

BY DJS DATE 12-4-80 PROJ. NO. 80-238-

CHKD. BY JRL DATE 12-15-80 SHEET NO. 1 OF 10

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DAM STATISTICS

HEIGHT OF DAM = 18.2 (FIELD MEASURED: TOP OF DAM TO OUTLET INVERT; "TOP OF DAM" HERE AND ON ALL SUBSEQUENT CALCULATION SHEETS REFERS TO THE ELEVATION OF THE LOW AREA IN THE EMBANKMENT CREST.)

NORMAL POOL STORAGE CAPACITY = 80 ACRE-FEET (HEC-1)

MAXIMUM POOL STORAGE CAPACITY = 112 ACRE-FEET (HEC-1)
(@ TOP OF DAM)

DRAINAGE AREA = 0.47 SQUARE MILES (PLANIMETERED ON USGS 7.5' TOPO QUAD – LAKE MASKENOZHA, PA.)

ELEVATIONS:

TOP OF DAM (DESIGN)	= NOT KNOWN	
TOP OF DAM (FIELD)	= 1237.0	(SEE NOTE 1)
NORMAL POOL	= 1225.0	(SEE NOTE 1 & SHEET 3)
UPSTREAM INLET INVERT (DESIGN)	= NOT KNOWN	
DOWNSTREAM OUTLET INVERT (DESIGN)	= NOT KNOWN	
DOWNSTREAM OUTLET INVERT (FIELD)	= 1208.8	(SEE NOTE 1)
STREAMBED @ DAM CENTERLINE	= NOT KNOWN	

NOTE 1: ORIGINAL NORMAL POOL ELEVATION ESTIMATED TO BE APPROXIMATELY AT 1225.0 FROM USGS TOPO QUAD – LAKE MASKENOZHA, PA. IT MUST BE NOTED THAT THE ELEVATIONS USED IN THIS ANALYSIS ARE CONSIDERED ESTIMATES ONLY, AND ARE NOT NECESSARILY ACCURATE.

SUBJECT DAM SAFETY INSPECTION
North Lake Dam

BY JJS DATE 12-15-80 PROJ. NO. 80-238

CHKD. BY JRL DATE 12-18-80 SHEET NO. 2 OF 10

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DAM CLASSIFICATION

DAM SIZE: SMALL (REF 1, TABLE 1)

HAZARD CLASSIFICATION: HIGH (FIELD OBSERVATION)

REQUIRED SDF: ½ PMF TO PMF (REF 1, TABLE 3)

HYDROGRAPH PARAMETERS

- LENGTH OF LONGEST WATERCOURSE: $L = 1.5$ MILES

- LENGTH OF LONGEST WATERCOURSE FROM DAM TO A POINT OPPOSITE BASIN CENTROID: $L_{CA} = 0.7$ MILES

(MEASURED ON LAKE MASKENOZHA, PA USGS TOPO QUAD)

$C_t = 1.23$
$C_p = 0.45$

(SUPPLIED BY C.O.E., ZONE 1, DELAWARE RIVER BASIN)

SNYDER STANDARD LAG:

$$t_p = C_t (L \cdot L_{ca})^{0.3}$$
$$= 1.23 (1.5 \times 0.7)^{0.3}$$
$$= 1.25 \text{ HOURS}$$

(NOTE: HYDROGRAPH VARIABLES USED HERE ARE DEFINED IN REF. 2, IN SECTION ENTITLED "SNYDER SYNTHETIC UNIT HYDROGRAPH.)

SUBJECT DAM SAFETY INSPECTION
NORTH LAKE DAM

BY DJS DATE 12-15-80 PROJ. NO. 80-238

CHKD. BY JRL DATE 12/18/80 SHEET NO. 3 OF 10

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RESERVOIR STORAGE CAPACITY

Reservoir Surface Areas:

Surface Area (S.A.) @ Original Normal Pool (El. 1225.0) = 15 acres

S.A. @ Elev. 1240.0 = 29 acres

(Planimetered on USGS Topo Quad - Lake Masikenozha, PA)

- S.A. @ top of dam (El. 1227.0) = 16.9 acres

(By linear interpolation)

The "zero-storage" elevation is assumed to be at 1209, or approximately at the same elevation as the downstream invert of the outlet conduit.

Elevation - Storage Relationship

The elevation - storage relationship is computed internally in the HEC-1 program, by use of the conic method, based on the given reservoir surface area and elevation data (see Summary Input/Output Sheets).

SUBJECT DAM SAFETY INSPECTION
NORTH LAKE DAM

BY DJS DATE 12-8-80 PROJ. NO. 80-238

CHKD. BY JRL DATE 12-15-80 SHEET NO. 4 OF 10

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PMP CALCULATIONS

- APPROXIMATE RAINFALL INDEX = 22.0 INCHES
  (CORRESPONDING TO A DURATION OF 24 HOURS AND A DRAINAGE AREA OF 200 SQUARE MILES.)

  (REF 3, FIG. 1)

- DEPTH-AREA-DURATION ZONE 1 (REF. 3, FIG. 1)

- ASSUME DATA CORRESPONDING TO A 10-SQUARE MILE AREA MAY BE APPLIED TO THIS 0.47-SQUARE MILE BASIN.

DURATION (HRS)	PERCENT OF INDEX RAINFALL
6	111
12	123
24	133
48	142

(REF 3, FIG. 3)

HOP BROOK FACTOR (ADJUSTMENT FOR BASIN SHAPE AND FOR THE LESSER LIKELIHOOD OF A SEVERE STORM CENTERING OVER A SMALL BASIN) FOR A DRAINAGE AREA OF 0.47 SQUARE MILES IS 0.80.

(REF 4, P. 48)

SUBJECT DAM SAFETY INSPECTION
NORTH LAKE DAM

BY JJS DATE 12-12-80 PROJ. NO. 80-238

CHKD. BY JRL DATE 12-18-80 SHEET NO. 5 OF 10

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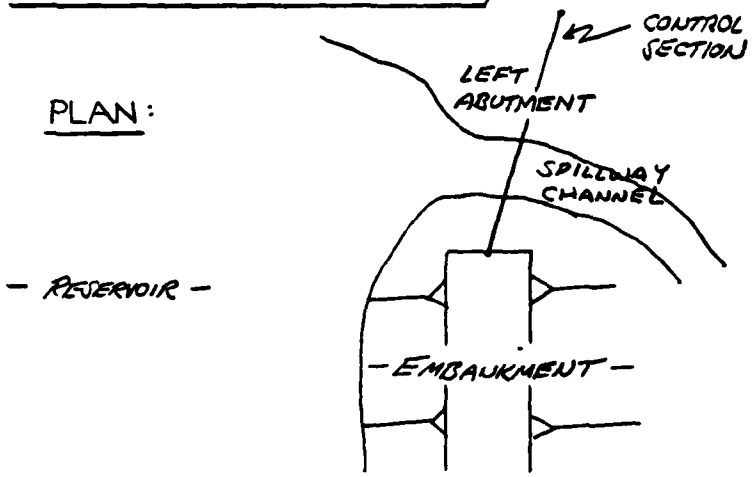
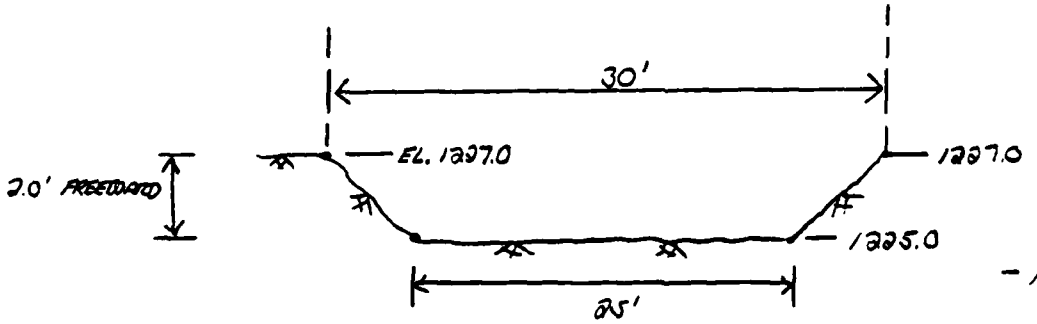
SPILLWAY CAPACITY

PLAN:



CONTROL SECTION:



- NOT TO SCALE -

- SKETCHES BASED ON FIELD NOTES AND OBSERVATIONS.

THE SPILLWAY CONSISTS OF AN UNCONTROLLED, ROUGHLY TRAPEZOIDAL CHANNEL CUT THROUGH SOIL AND ROCK AT THE LEFT ABUTMENT. AT THE TIME OF INSPECTION, THERE WAS A SMALL EARTH AND ROCK DIKE CONSTRUCTED ACROSS THE SPILLWAY CHANNEL, FOR THE PURPOSE OF RAISING THE RESERVOIR LEVEL. IT WILL BE ASSUMED IN THE SPILLWAY COMPUTATIONS THAT THE SMALL DIKE IS REMOVED (THE AVAILABLE FREEBOARD WITH THE DIKE IN PLACE IS ONLY 0.2 FT, RESULTING IN A GREATLY REDUCED SPILLWAY CAPACITY).

SUBJECT DAM SAFETY INSPECTION
NORTH LAKE DAM

BY JJS DATE 12-12-80 PROJ. NO. 80-233

CHKD. BY [illegible] DATE 12-19-80 SHEET NO. 6 OF 10

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THE CONTROL SECTION IS LOCATED NEAR THE RESERVOIR OUTLET, AS SHOWN ON THE SKETCH ON SHEET 5. THE ASSUMED DIMENSIONS OF THE "ORIGINAL" CONTROL SECTION ARE ALSO SHOWN ON SHEET 5. ASSUMING THAT CRITICAL FLOW OCCURS AT THE CONTROL SECTION,

$$\frac{Q^2 T}{g A^3} = 1.0 \qquad \text{(REF 5, p 8-7)}$$

WHERE Q = DISCHARGE, IN CFS,
T = TOP WIDTH OF FLOW AREA, IN FT,
g = GRAVITATIONAL ACCELERATION CONSTANT = 32.2 FT/SEC^2,
A = FLOW AREA, IN FT.^{2}

ALSO,

$$Hm = Dc + \frac{Dm}{2}$$

AND

$$Dm = A/T \qquad \text{(REF 5, p 8-8)}$$

WHERE

Hm = TOTAL HEAD AT CRITICAL DEPTH, OR MINIMUM SPECIFIC ENERGY, IN FT,
Dc = CRITICAL DEPTH, IN FT,
Dm = MEAN DEPTH OF FLOW AREA, IN FT.

THE RESERVOIR ELEVATION CORRESPONDING TO ANY PARTICULAR DISCHARGE IS THEN $Hm + 1225.0$ (WHERE INVERT OF CONTROL SECTION = 1225.0). THIS IS BASED ON THE ASSUMPTION OF ZERO-VELOCITY HEAD AT THE RESERVOIR JUST UPSTREAM OF THE CONTROL SECTION, AND NEGLIGIBLE HEAD LOSS TO THE CONTROL SECTION → NO APPROACH LOSSES.

SUBJECT DAM SAFETY INSPECTION
NORTH LAKE DAM

BY DJS DATE 12-12-80 PROJ. NO. 80-238

CHKD. BY JW DATE 12-18-80 SHEET NO. 7 OF 10

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SPILLWAY RATING TABLE:

D_c (FT)	A ① (FT^2)	T ② (FT)	D_m ③ (FT)	H_m ④ (FT)	Q ⑤ (CFS)	RESERVOIR ELEVATION ⑥ (FT)
0.5	12.81	26.25	0.49	0.7	51	1225.7
1.0	26.25	27.50	0.95	1.5	146	1226.5
1.5	40.31	28.75	1.40	2.2	271	1227.2
2.0	55.00	30.00	1.83	2.9	423	1227.9
2.5	70.00	30.00	2.33	3.7	607	1228.7
3.0	85.00	30.00	2.83	4.4	812	1229.4
3.5	100.00	30.00	3.33	5.2	1036	1230.2
4.0	115.00	30.00	3.83	5.9	1278	1230.9

① FOR $D_c \leq 2.0$, $A = 25D_c + 1.25D_c^2$
FOR $D_c > 2.0$, $A = 55 + 30(D_c - 2)$

② FOR $D_c \leq 2.0$, $T = 25 + 2.5D_c$
FOR $D_c > 2.0$, $T = 30.0$

③ $D_m = A/T$

④ $H_m = D_c + D_m/2$

⑤ $Q = \sqrt{gA^3/T}$

⑥ RESERVOIR ELEVATION $= H_m + 1225.0$

SUBJECT DAM SAFETY INSPECTION
NORTH LAKE DAM

BY DJS DATE 12-15-80 PROJ. NO. 80-228

CHKD. BY [illegible] DATE 12-18-80 SHEET NO. 8 OF 16

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EMBANKMENT RATING CURVE

ASSUME THAT THE EMBANKMENT BEHAVES ESSENTIALLY AS A BROAD-CRESTED WEIR WHEN OVERTOPPING OCCURS. THUS, THE DISCHARGE CAN BE ESTIMATED BY THE RELATIONSHIP

$$Q = CLH^{3/2} \qquad \text{(REF 5, p. 5-23)}$$

WHERE

Q = DISCHARGE OVER EMBANKMENT, IN CFS,
L = LENGTH OF EMBANKMENT OVERTOPPED, IN FT,
H = HEAD ON WEIR; IN THIS CASE, H IS THE AVERAGE "FLOW-AREA WEIGHTED" HEAD ABOVE THE LOW TOP OF THE DAM,
C = COEFFICIENT OF DISCHARGE, DEPENDENT UPON THE HEAD AND THE WEIR BREADTH.

LENGTH OF EMBANKMENT INUNDATED VS. RESERVOIR ELEVATION:

	RESERVOIR ELEVATION (FT)	EMBANKMENT LENGTH (FT)	RESERVOIR ELEVATION (FT)	EMBANKMENT LENGTH (FT)
	1226.9 *	0	1229.0	420
(TOP OF DAM)	1227.0	15	1229.3	580
	1227.1	30	1229.5	755
	1227.9	60	1229.8	765
	1228.3	105	1230.0	770
	1228.6	135	1230.5	780
	1228.7	265	1231.0	790
	1228.8	315		

(FROM FIELD SURVEY AND USGS TOPO 7½ MIN - LAKE MADRONE, CA.)

* - A PORTION OF THE LEFT ABUTMENT IS AT A LOWER ELEVATION THAN THAT OF THE LOW TOP OF DAM.

SUBJECT DAM SAFETY INSPECTION
NORTH LAKE DAM

BY JJS DATE 12-15-80 PROJ. NO. 80-239

CHKD. BY JK DATE 12-18-80 SHEET NO. 9 OF 10

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ASSUME THAT INCREMENTAL DISCHARGES FOR SUCCESSIVE RESERVOIR ELEVATIONS ARE APPROXIMATELY TRAPEZOIDAL IN CROSS-SECTIONAL FLOW AREA. THEN ANY INCREMENTAL AREA OF FLOW CAN BE ESTIMATED AS $H_i [(L_1 + L_2)/2]$, WHERE L_1 = LENGTH OF EMBANKMENT OVERTOPPED AT HIGHER ELEVATION, L_2 = LENGTH AT LOWER ELEVATION, H_i = DIFFERENCE IN ELEVATIONS. THUS, THE TOTAL AVERAGE "FLOW AREA WEIGHTED" HEAD CAN BE ESTIMATED AS $H_w = (\text{TOTAL FLOW AREA} / L_1)$.

EMBANKMENT RATING CURVE:

RESERVOIR ELEVATION (FT)	L_1 (FT)	L_2 (FT)	INCREMENTAL HEAD, H_i (FT)	INCREMENTAL AREA, A_i (FT²) ①	TOTAL FLOW AREA, A_T (FT²)	WEIGHTED HEAD, H_w (FT) ②	H_w/l ④	C ④	Q ⑤ (CFS)
1226.9	0	—	—	—	—	—	—	—	0
(TOP OF DAM) 1227.0	15	0	0.1	1	1	0.07	0.004	2.93	0
1227.1	30	15	0.1	2	3	0.10	0.005	2.93	0
1227.9	60	30	0.8	36	39	0.65	0.03	3.03	100
1228.3	105	60	0.4	33	72	0.69	0.04	3.03	180
1228.6	135	105	0.3	36	108	0.80	0.04	3.03	270 *
1228.7	265	135	0.1	20	128	0.48	0.03	3.02	270
1228.8	315	265	0.1	29	157	0.50	0.03	3.02	340
1229.0	420	315	0.2	74	231	0.55	0.03	3.02	520
1229.3	580	420	0.3	150	381	0.66	0.03	3.03	940
1229.5	755	580	0.2	134	514	0.68	0.04	3.03	1280
1229.8	765	755	0.3	228	742	0.97	0.05	3.03	2210
1230.0	770	765	0.2	154	896	1.2	0.06	3.04	3080
1230.5	780	770	0.5	388	1283	1.6	0.08	3.04	4800
1231.0	790	780	0.5	393	1676	2.1	0.11	3.04	7310

① $A_i = H_i \left[\frac{(L_1 + L_2)}{2}\right]$

② $H_w = A_T / L_1$

③ l = BREADTH OF CREST = 19 FT (AVG. VALUE)

④ $C = f(H, l)$; FROM REF 12, FIG. 24

⑤ $Q = CL_1 H_w^{3/2}$

* — SINCE THE DISCHARGE AT ELEV. 1228.7 = 270 CFS, THE VALUE AT ELEV. 1228.6 WILL BE LIMITED TO 270 CFS.

SUBJECT DAM SAFETY INSPECTION
NORTH LAKE DAM

BY JJS DATE 12-15-80 PROJ. NO. 80-238

CHKD. BY JRL DATE 12-18-80 SHEET NO. 10 OF 10

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TOTAL FACILITY RATING CURVE

$$Q_{TOTAL} = Q_{SPILLWAY} + Q_{EMBANKMENT}$$

RESERVOIR ELEVATION (FT)	$Q_{SPILLWAY}$ ① (CFS)	$Q_{EMBANKMENT}$ ② (CFS)	Q_{TOTAL} (CFS)
1225.0	0	–	0
1225.5	40	–	40
1226.0	90	–	90
1226.5	150	–	150
(TOP OF DAM) 1227.0	240	0	240
1227.2	270	10	280
1227.9	420	100	520
1228.3	520	180	700
1228.5	560	240	800
1228.7	610	270	880
1229.0	690	520	1210
1229.3	780	940	1720
1229.5	840	1280	2120

① FROM RATING TABLE, SHEET 7, BY LINEAR INTERPOLATION; ROUNDED TO NEAREST 10 CFS.

② FROM RATING TABLE, SHEET 9; ROUNDED TO NEAREST 10 CFS.

SUBJECT DAM SAFETY INSPECTION

BY WJV DATE 12-22-80 PROJ. NO. 80-238-268

CHKD. BY DJS DATE 12-22-80 SHEET NO. A OF D

SUMMARY INPUT/OUTPUT SHEETS

OVERTOPPING ANALYSIS

DAM SAFETY INSPECTION
NORTH LAKE DAM **** OVERTOPPING ANALYSIS ****
10-MINUTE TIME STEP AND 48-HOUR STORM DURATION

JOB SPECIFICATION

NO	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
200	0	10	0	0	0	0	0	0	0

JOPER	NWT	LKOPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLANS= 1 NRTIO= 5 LRTIO= 1

RTIOS= .10 .20 .30 .50 1.00

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

RESERVOIR INFLOW COMPUTATION

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUNG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISMON	ISAME	LOCAL
1	1	.47	0.00	.47	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	22.00	111.00	123.00	133.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .000

INITIAL AND CONSTANT RAINFALL LOSSES AS PER COE

LOSS DATA

LKOPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA
TP= 1.25 CP= .45 NTA= 0

BASEFLOW PARAMETERS AS PER COE

RECESSION DATA
STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC= 7.92 AND R=11.95 INTERVALS

UNIT HYDROGRAPH 66 END-OF-PERIOD ORDINATES, LAG= 1.25 HOURS, CP= .45 VOL= 1.00

5.	17.	35.	57.	78.	95	107.	110.	106.	97.
89.	82.	76.	69.	64.	59.	54.	50.	46.	42.
39.	36.	33.	30.	28.	25.	23.	22.	20.	18.
17.	15.	14.	13.	12.	11.	10.	9.	9.	8.
7.	7.	6.	6.	5.	5.	4.	4.	4.	3.
3.	3.	3.	2.	2.	2.	2.	2.	2.	1.
1.	1.	1.	1.	1.	1.	1.	1.		

0 END-OF-PERIOD FLOW

HU.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	CUMP Q	HU.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	CUMP Q
									SUM	24.99	22.60	2.39	39815.
										(635.1)	(574.3)	(61.)	(1127.44)

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SUBJECT DAM SAFETY INSPECTION

NORTH LAKE DAM

BY WJV DATE 12-22-80 PROJ. NO. 80-239-269

CHKD. BY DJS DATE 12-22-80 SHEET NO. B OF D

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RESERVOIR INFLOW HYDROGRAPHS

0.2 PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	241.	160.	54.	28.	7953.
CMS	7.	5.	2.	1.	225.
INCHES		3.17	4.30	4.37	4.37
MM		80.46	109.11	111.06	111.06
AC-FT		79.	108.	110.	110.
THOUS CU M		98.	133.	135.	135.

0.3 PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	362.	240.	81.	41.	11930.
CMS	10.	7.	2.	1.	338.
INCHES		4.75	6.44	6.56	6.56
MM		120.70	163.66	166.60	166.60
AC-FT		119.	161.	164.	164.
THOUS CU M		147.	198.	203.	203.

0.5 PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	603.	400.	136.	69.	19883.
CMS	17.	11.	4.	2.	563.
INCHES		7.92	10.74	10.93	10.93
MM		201.16	272.77	277.66	277.66
AC-FT		196.	269.	274.	274.
THOUS CU M		245.	332.	338.	338.

PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1207.	800.	271.	138.	39767.
CMS	34.	23.	8.	4.	1126.
INCHES		15.84	21.48	21.86	21.86
MM		402.32	545.54	555.32	555.32
AC-FT		397.	538.	548.	548.
THOUS CU M		489.	664.	676.	676.

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE THROUGH RESERVOIR

ISTAO	ICOMP	ICON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
101	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1225.	-1

STAGE	1225.00	1225.50	1226.00	1226.50	1227.00	1227.20	1227.90	1228.30	1228.50
	1229.00	1229.30	1229.50						
FLOW	0.00	40.00	90.00	150.00	240.00	280.00	520.00	700.00	800.00
	1210.00	1720.00	2120.00						
SURFACE AREA=	0.	15.	17.	29.					
CAPACITY=	0.	80.	112.	407.					
ELEVATIONS=	1209.	1225.	1227.	1240.					

SUBJECT DAM SAFETY INSPECTION

NORTH LAKE DAM

BY WJV DATE 12-22-80 PROJ. NO. 80-239-269

CHKD. BY DJS DATE 12-22-80 SHEET NO. C OF D

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CHEL	SPWID	COOW	EXPW	ELEVL	COOL	CANEA	EXPL
1225.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
1227.0	0.0	0.0	0.

RESERVOIR OUTFLOW HYDROGRAPHS

PEAK OUTFLOW IS 190. AT TIME 42.33 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	190.	145.	50.	25.	7319.
CMS	5.	4.	1.	1.	207.
INCHES		2.86	3.96	4.02	4.02
MM		72.71	100.53	102.21	102.21
AC-FT		72.	99.	101.	101.
THOUS CU M		88.	122.	124.	124.

0.2 PMF

PEAK OUTFLOW IS 304. AT TIME 42.00 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	304.	222.	76.	39.	11092.
CMS	9.	6.	2.	1.	314.
INCHES		4.39	6.00	6.10	6.10
MM		111.62	152.37	154.90	154.90
AC-FT		110.	150.	153.	153.
THOUS CU M		136.	185.	188.	188.

0.3 PMF

PEAK OUTFLOW IS 545. AT TIME 41.67 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	545.	362.	128.	65.	18726.
CMS	15.	11.	4.	2.	530.
INCHES		7.55	10.13	10.30	10.30
MM		191.88	257.30	261.50	261.50
AC-FT		189.	254.	259.	259.
THOUS CU M		233.	313.	318.	318.

0.5 PMF

PEAK OUTFLOW IS 1177. AT TIME 41.17 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1177.	786.	260.	132.	38061.
CMS	33.	22.	7.	4.	1078.
INCHES		15.56	20.59	20.93	20.93
MM		395.33	523.10	531.50	531.50
AC-FT		390.	516.	524.	524.
THOUS CU M		481.	636.	647.	647.

PMF

SUBJECT DAM SAFETY INSPECTION
NORTH LAKE DAM

BY WJV DATE 12-22-80 PROJ. NO. 80-239-269

CHKD. BY DJS DATE 12-22-80 SHEET NO. D OF D

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SUMMARY OF DAM SAFETY ANALYSIS

	ELEVATION STORAGE OUTFLOW	INITIAL VALUE 1225.00 0. 0.	SPILLWAY CREST 1225.00 80. 0.	TOP OF DAM 1227.00 112. 240.				
RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS	
.10	1225.98	0.00	95.	95.	0.00	42.67	0.00	
.20	1226.72	0.00	107.	190.	0.00	42.33	0.00	
.30	1227.27	.27	116.	304.	2.67	42.00	0.00	
.50	1227.96	.96	128.	545.	5.00	41.67	0.00	
1.00	1228.97	1.97	147.	1177.	9.00	41.17	0.00	

OVERTOPPING OCCURS @ ≈ 0.24 PMF

LIST OF REFERENCES

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APPENDIX E

FIGURES

LIST OF FIGURES

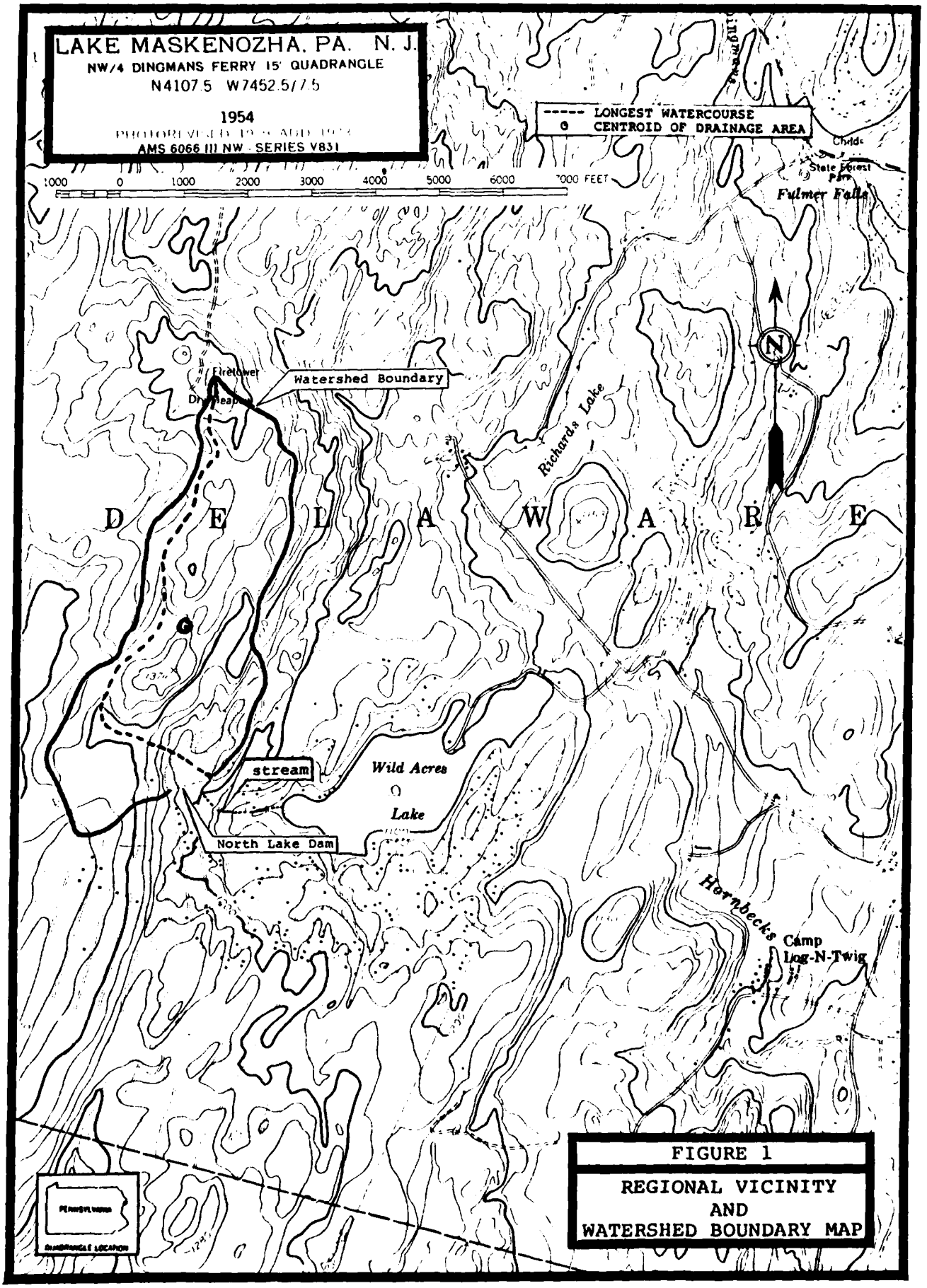

FIGURE 1

REGIONAL VICINITY AND WATERSHED BOUNDARY MAP

APPENDIX F

GEOLOGY

Geology

North Lake Dam is located in the glaciated Low Plateaus section of the Appalachian Plateaus physiographic province of eastern Pennsylvania. In this area, the Appalachian Plateaus province is characterized topographically by flat-topped, hummocky hills formed as a result of glaciation and subsequent stream dissection of nearly flat-lying strata. The Devonian age sedimentary rock strata in Pike County regionally strike N35°E and dip gently to the northwest. The Delaware River is the major drainage basin in the area. Major tributary streams intersect the Delaware River at right angles; whereas, smaller streams display a slightly more random tributary pattern. Both major and minor tributary stream systems are joint controlled and exhibit modified rectangular and trellis-type drainage patterns.

Structurally, the area containing Pike County lies on the south flank of a broad, asymmetrical synclinorium that plunges to the southwest. Superimposed on this broad structural basin are numerous anticlinal and synclinal folds characterized by planar limbs and narrow hinges. Due to prior glaciation, low relief and surficial soil cover, fold axes are difficult to trace.

The sedimentary rock sequences in the vicinity of the dam and reservoir are probably members of the Susquehanna Group of Upper Devonian age (see Geology Map). The sedimentological changes observed in the Catskill Formation indicate that the rate of sedimentation exceeded the rate of basin subsidence resulting in a facies change from marine to non-marine strata. On the accompanying geology map the delineation between the Middle and Upper Devonian age sedimentary rock sequences represents the Allegheny Front which separates the Valley and Ridge physiographic province from the Appalachian Plateaus physiographic province.

Approximately half of Pike County, including the dam site, is covered by a blanket of Wisconsin age (most recent) glacial drift which, based on the degree of weathering, was probably deposited during the Woodfordian stage. Valley bottoms are typically covered by recent alluvium and Woodfordian outwash of variable thickness, but typically less than 10 feet. These deposits are characteristically unconsolidated stratified sand and gravel usually with more gravel than sand and some small boulders. The direction of the Wisconsin ice advance, was from the northeast over the Catskill Mountains and from the north over the Appalachian Plateau. The terminal moraine resulting from the southern most advance of the Wisconsin ice sheet in this area is located in the southern portion of Monroe County which borders Pike County to the South.

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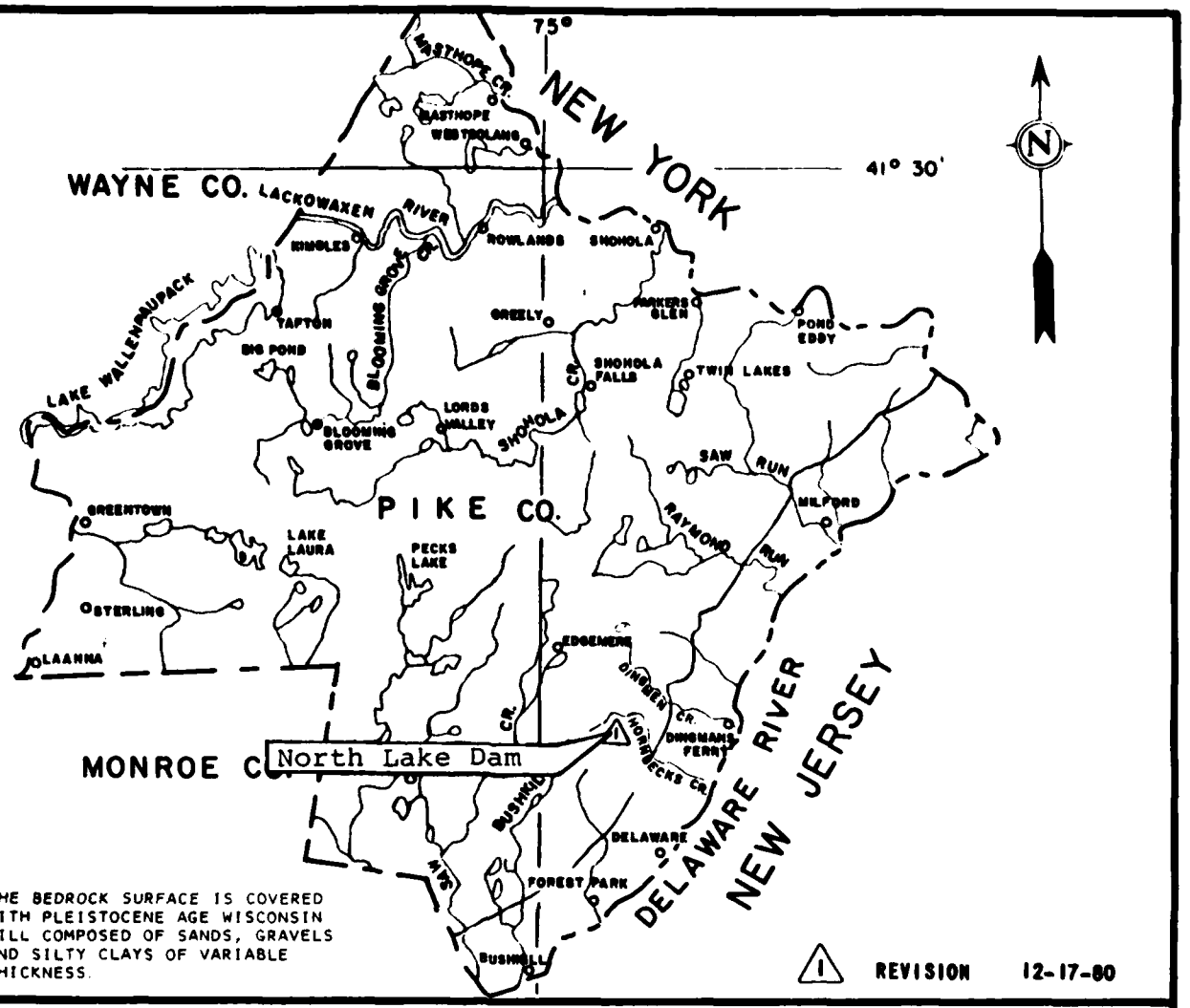

NOTE: THE BEDROCK SURFACE IS COVERED WITH PLEISTOCENE AGE WISCONSIN TILL COMPOSED OF SANDS, GRAVELS AND SILTY CLAYS OF VARIABLE THICKNESS.

1 REVISION 12-17-80

LEGEND

UPPER DEVONIAN

SUSQUEHANNA GROUP

Catskill Formation - *Shohola Member interbedded 5- to 25-foot thick units of greenish-gray and grayish-red very fine to medium-grained sandstone and sandy shale and lesser medium-gray to medium-dark-gray sandstone and shale. Sandstones are predominantly low-rank graywackes. Beds are thin to even thick and most have simple or planar sets of small- to medium-scale, generally low-angle cross stratification. Contacts with shale units are abruptly disconformable to gradational. Sandstones are poorly sorted. Shale is thinly laminated and well cleaved. Mud cracks, convolute bedding, and ripple marks are present near contacts with sandstone units. Member is more than 2,000 feet thick. Lower contact is gradational and is placed at top of highest red bed of the underlying Analomink. Analomink Red Shale Member, medium-grayish-red silty, micaceous, finely laminated well-cleaved shale containing thin beds of brownish-gray sandy siltstone and silty very fine grained sandstone. Unit in the "first red" going up section in Upper Devonian sequence. Member is about 100 feet thick. Lower contact is gradational and is placed at the base of lowest red bed. Delaware River Flags Member, grayish-green, micaceous, laminated sandstone and lesser interbedded sandy shale. Beds range from a few inches to as much as 4 feet thick. Sandstones are low-rank graywackes and contain no marine fossils. Member is about 300 feet thick. Lower contact is gradational.*

MIDDLE DEVONIAN

HAMILTON GROUP

Mahantango Formation - *Upper member medium-dark-gray, fairly coarse grained, thin-bedded siltstone and silty shale; member is about 700 feet thick and is separated from lower member by the "Centerfield Reef," a calcareous siltstone biostrome containing abundant horn corals. The Centerfield is about 75 feet thick. Lower member, virtually same lithology as upper member. Unit is about 1,100 feet thick. Lower contact is gradational.*

Marcellus Shale - *Dark-gray, evenly laminated, silty clay shale and clayey silt shale. Unit commonly contains very hard limy concretions and is well cleaved; bedding is generally obscured. Member is about 75-feet thick. Lower contact is gradational.*

SCALE

0 6 12 18 MILES

REFERENCE:
GEOLOGIC MAP OF NORTHEASTERN PENNSYLVANIA. COMPILED BY GEO. W. STOSE AND O.A. LJUNGSTEDT COMMONWEALTH OF PENNSYLVANIA DEPT. OF INTERNAL AFFAIRS DATED 1932, SCALE 1" = 6 MILES.

GEOLOGY MAP

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END

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